

Making the Business Case for Building Commissioning

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April 15, 2010

DATA PROVIDERS



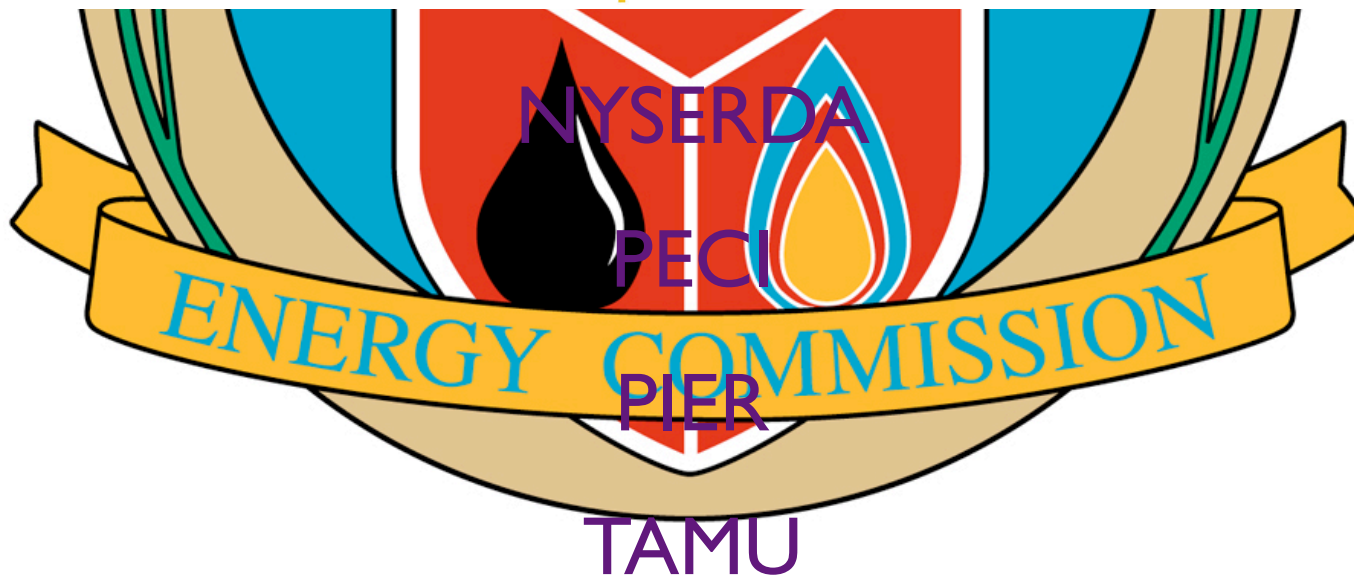
California Institute
for Energy & Environment

U.S. DEPARTMENT OF
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Energy Efficiency &
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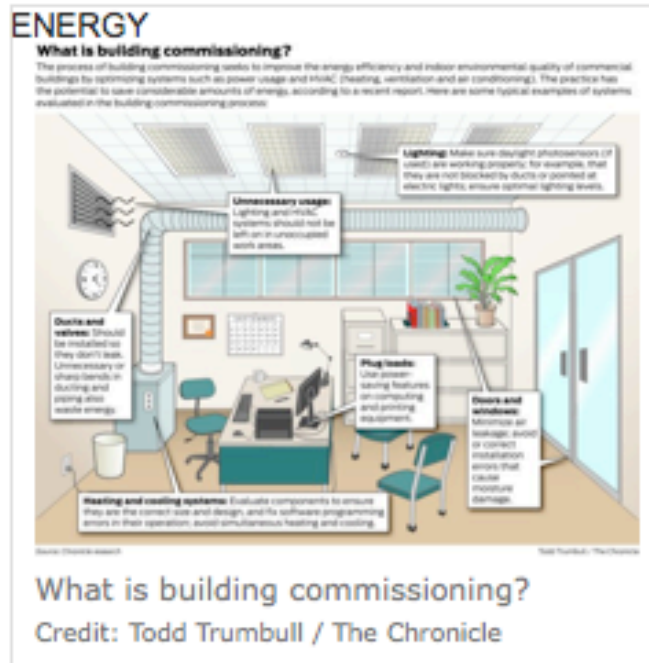
Cx is Front-Page News

San Francisco Chronicle - Sunday, September 6, 2009

San Francisco Chronicle

Fine-tuning buildings' energy systems urged

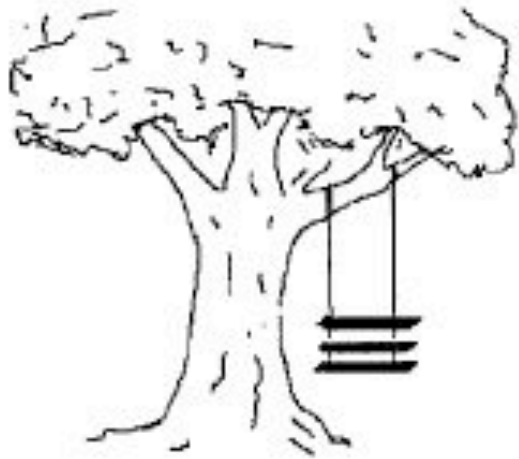
September 06, 2009 | By Matthew B. Stannard, Chronicle Staff Writer



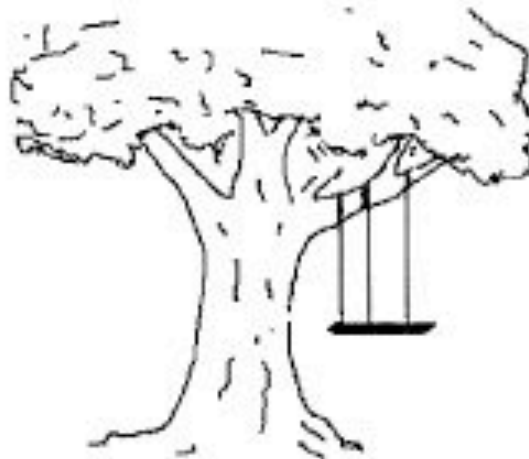
What if there were a way to save the nation \$30 billion a year in energy costs, reduce greenhouse gas emissions by more than 300 million tons a year and create thousands of new jobs - using existing technologies and at a price so cheap that it would pay for itself in the first year?

Evan Mills, a researcher at the Lawrence Berkeley National Laboratory, says there already

is one: building commissioning, the art and science of maximizing the energy efficiency of commercial buildings.



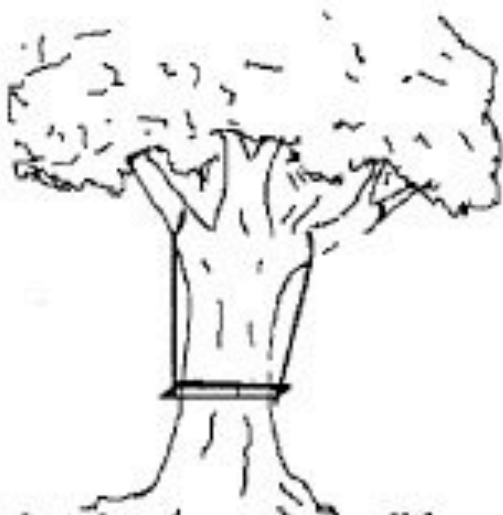
What the user asked for ...



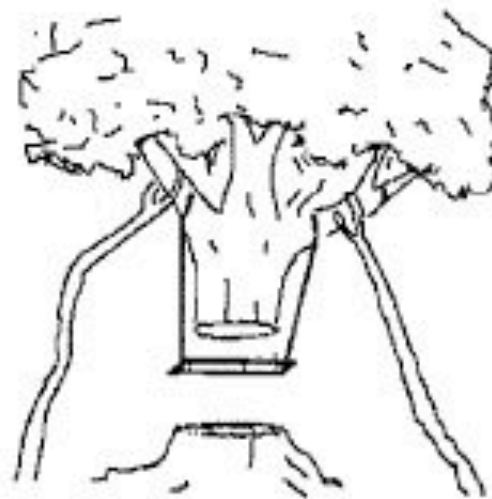
What the feasibility study said..



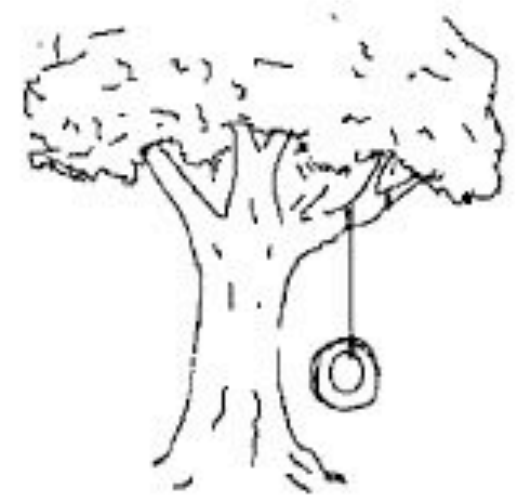
After value engineering ...



What the plans specified ...



As built ...



What the client really wanted.

Hall of Shame



Hot water valve motion impeded by piping layout
[EMC no date (a)]



Exhaust fan hardwired in an "always on" position [Mittal and Hammond 2008]



Zone damper actuator arm broken (no temperature control)
[Martha Hewett, MNCEE]



Rust indicates poor anti-condensation heating control setpoints in supermarket refrigeration cabinet [Sellers and Zazzara 2004]



Inadequate fan cooling and excessive fan power due to poor fit between the light fixture and ducting, causing significant duct leakage [Martha Hewett, MNCEE]

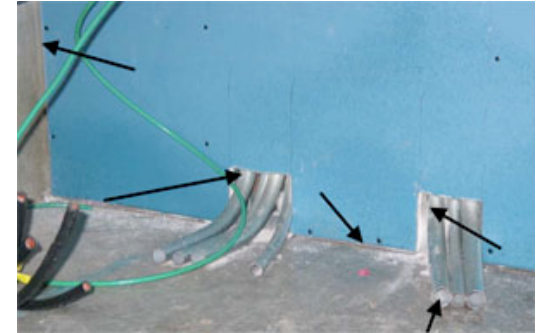
Hall of Shame



Damage to brick façade of pool building due to lack of proper sealing and air management [Martha Hewet, Minnesota Center for Energy and Environment (MNCEE)]



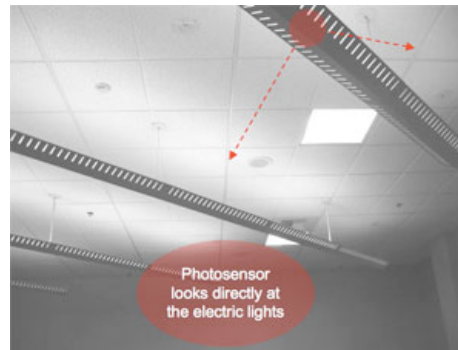
Building envelope moisture entry [Aldous 2008]



Air leakage in an underfloor air-distribution system [Stum 2008]



Photosensor (for daylight harvesting) shaded by duct [Deringer 2008]



Photosensor “sees” the electric lamps rather than task-plane illumination [Deringer 2008]



Failed window film applications

Commissioning as risk management

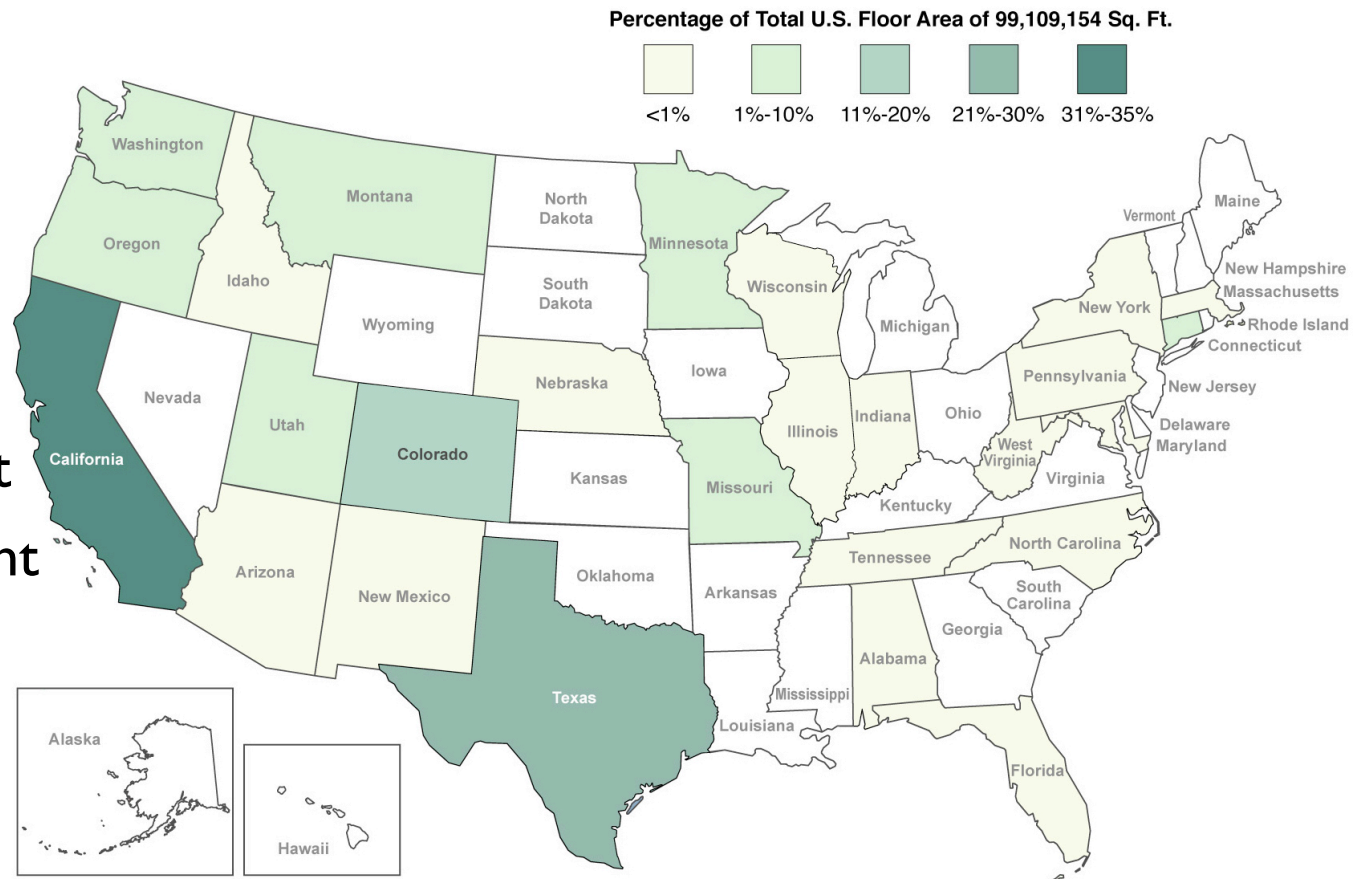
- Commissioning is more than “just another pretty energy-saving measure.”
- It is a risk-management strategy that should be integral to any systematic approach to garnering energy savings or emissions reductions.
 - Ensures that a building owners get what they pay for when constructing or retrofitting buildings
 - Provides insurance for policymakers and program managers that their initiatives actually meet targets
 - Detects and corrects problems that would eventually surface as far more costly maintenance or safety issues.

Making the Business Case

- Gather data on actual commissioning projects in new and existing buildings
- Remove uncertainties regarding the savings and cost-effectiveness of commissioning new and existing commercial buildings
- Document patterns of energy and non-energy issues identified and addressed in the commissioning process
- Perform a standardized analysis of energy savings, carbon reductions, and cost-effectiveness
- Estimate the national (U.S.) savings potential and required job creation

LBNL National Study

- 643 buildings
 - 562 existing
 - 82 new
- 19 building types
- 99 million square feet
- \$43 million investment
- 26 states
- 37 Cx providers



Caveats & conservatisms

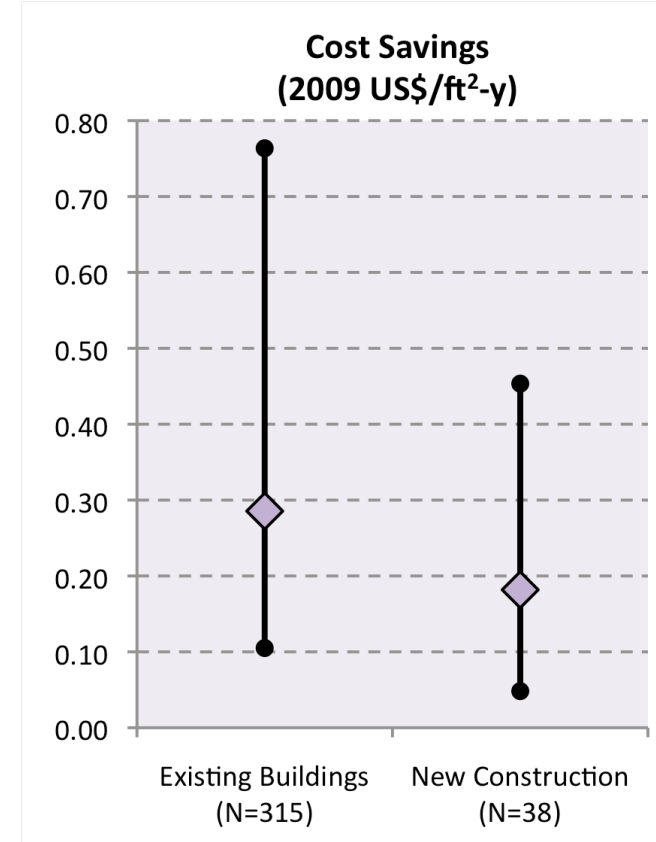
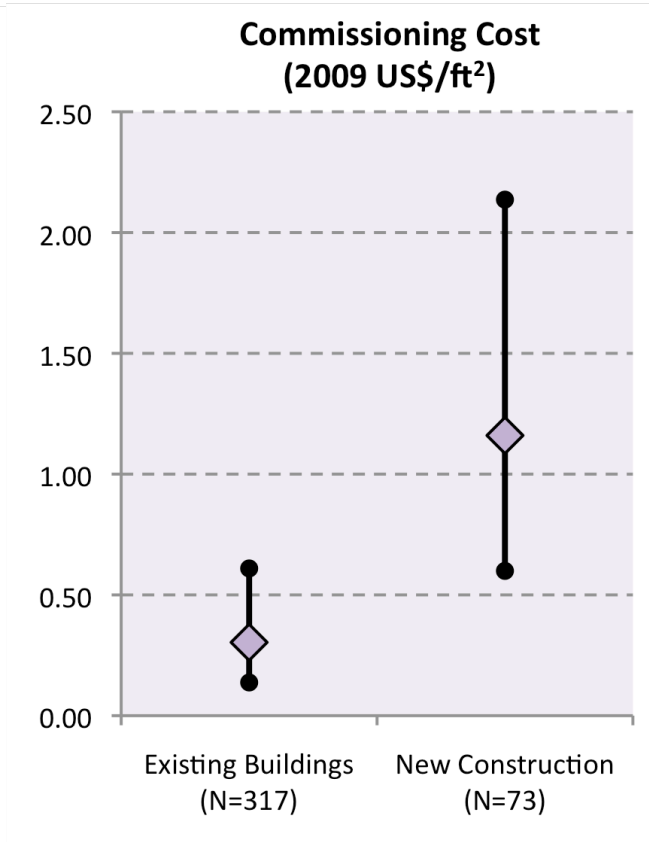
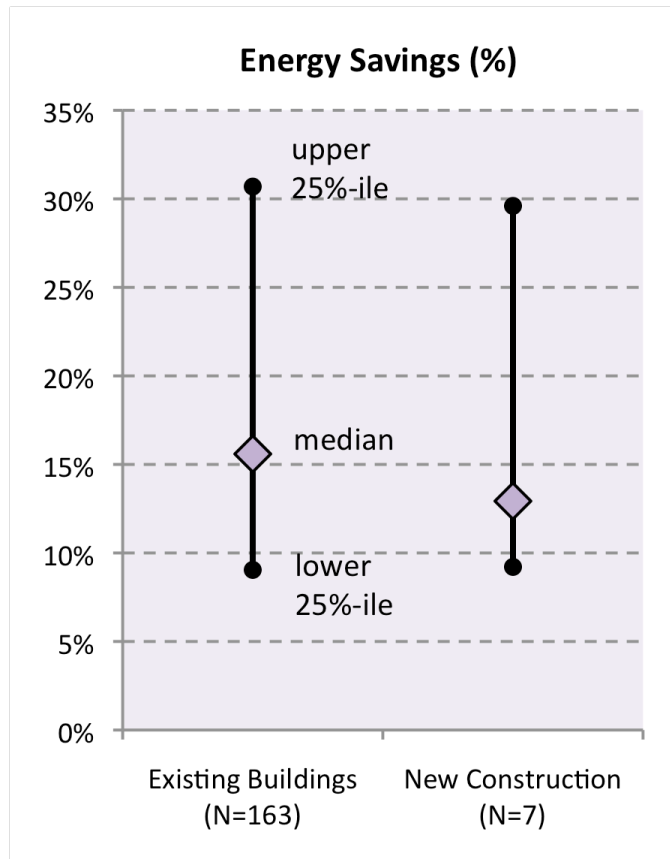
Underestimation of benefits

- Limited scope/ambition
- Costs for non-energy measures
- Non-energy impacts
- Measures implemented after data collected
- Delayed benefits (e.g. via training)

Overestimation of benefits

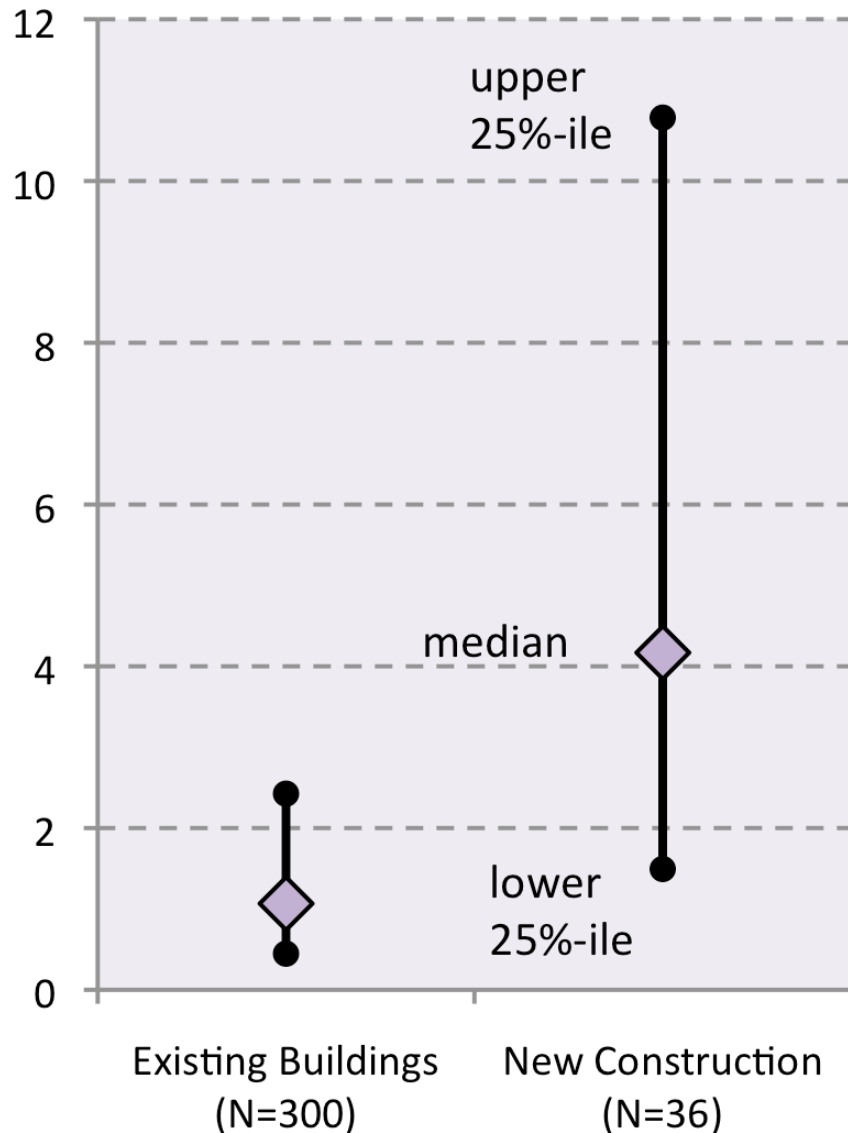
- Persistence
- Recommended measures not implemented
- Undocumented retrofit

Performance benchmarks

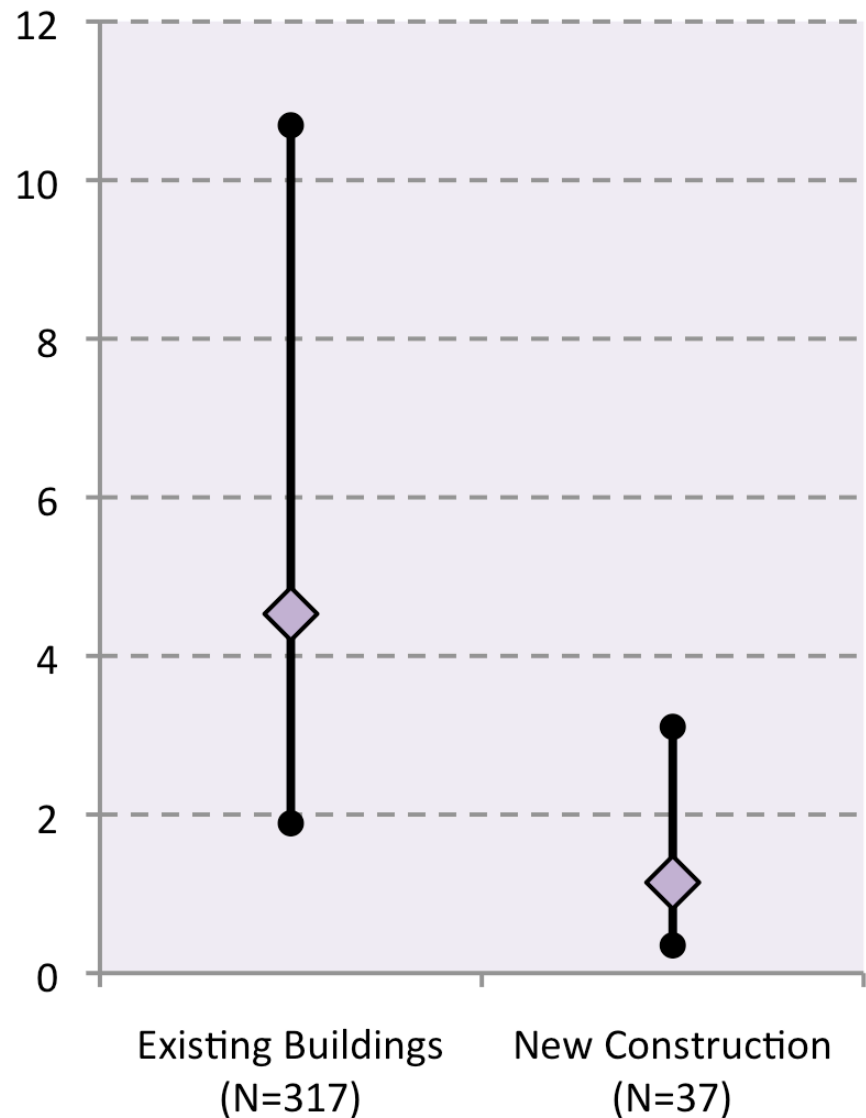


Projects are highly cost-effective

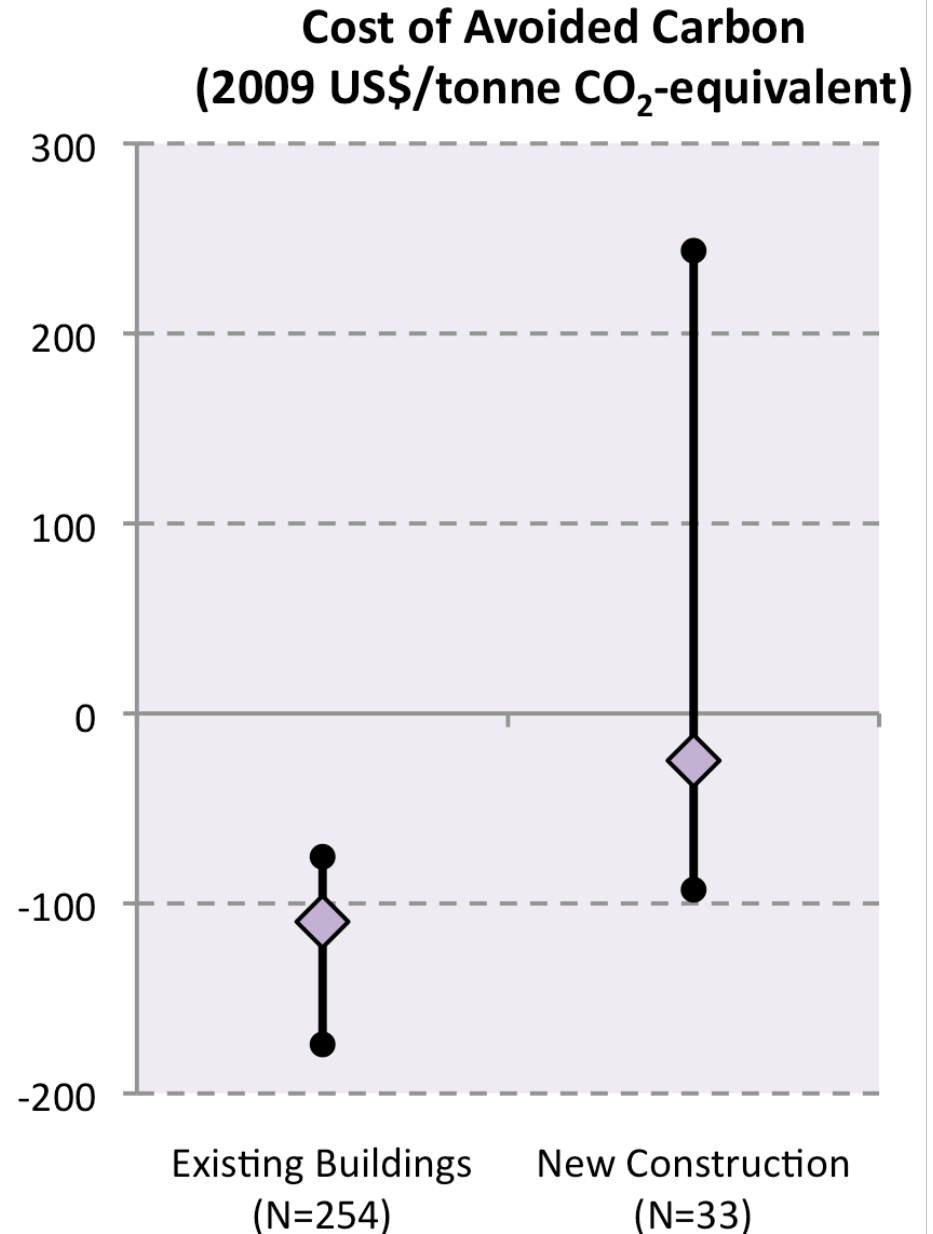
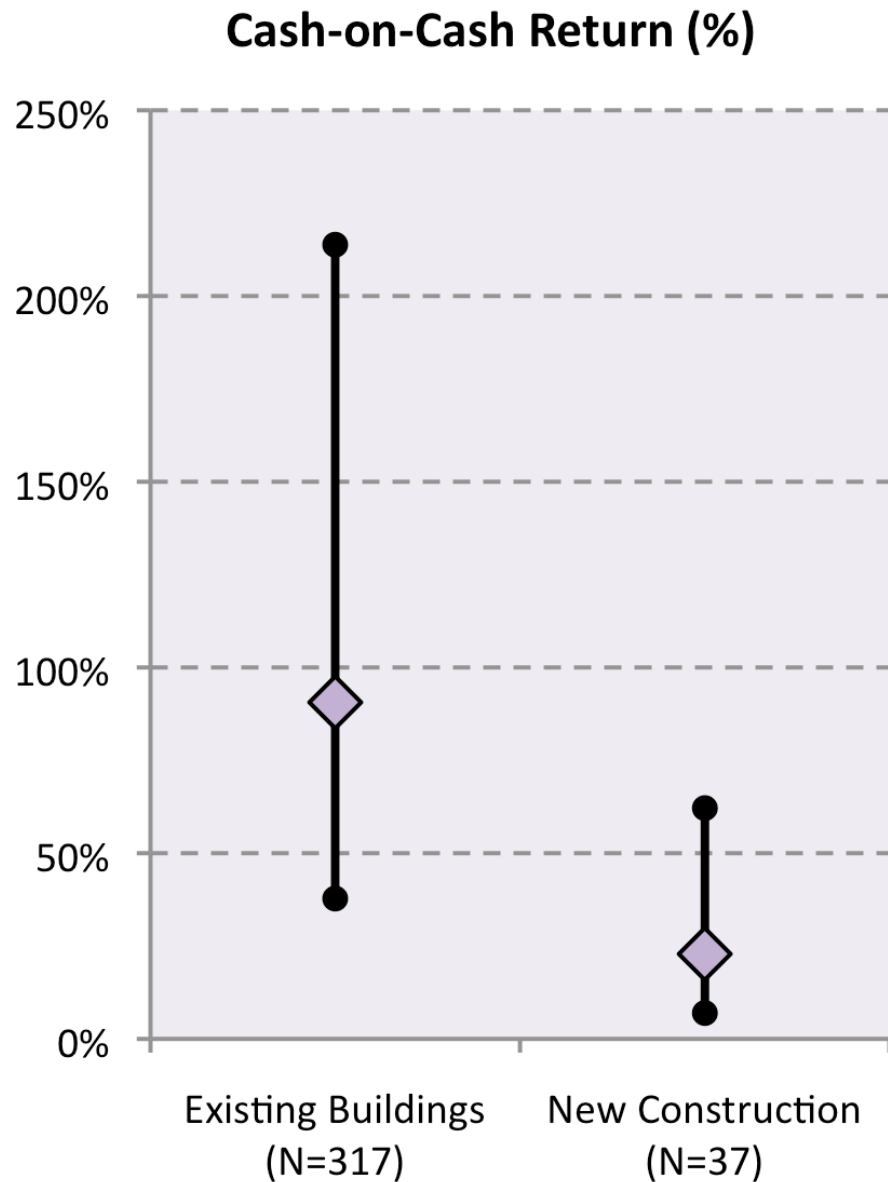
Payback Time (years)



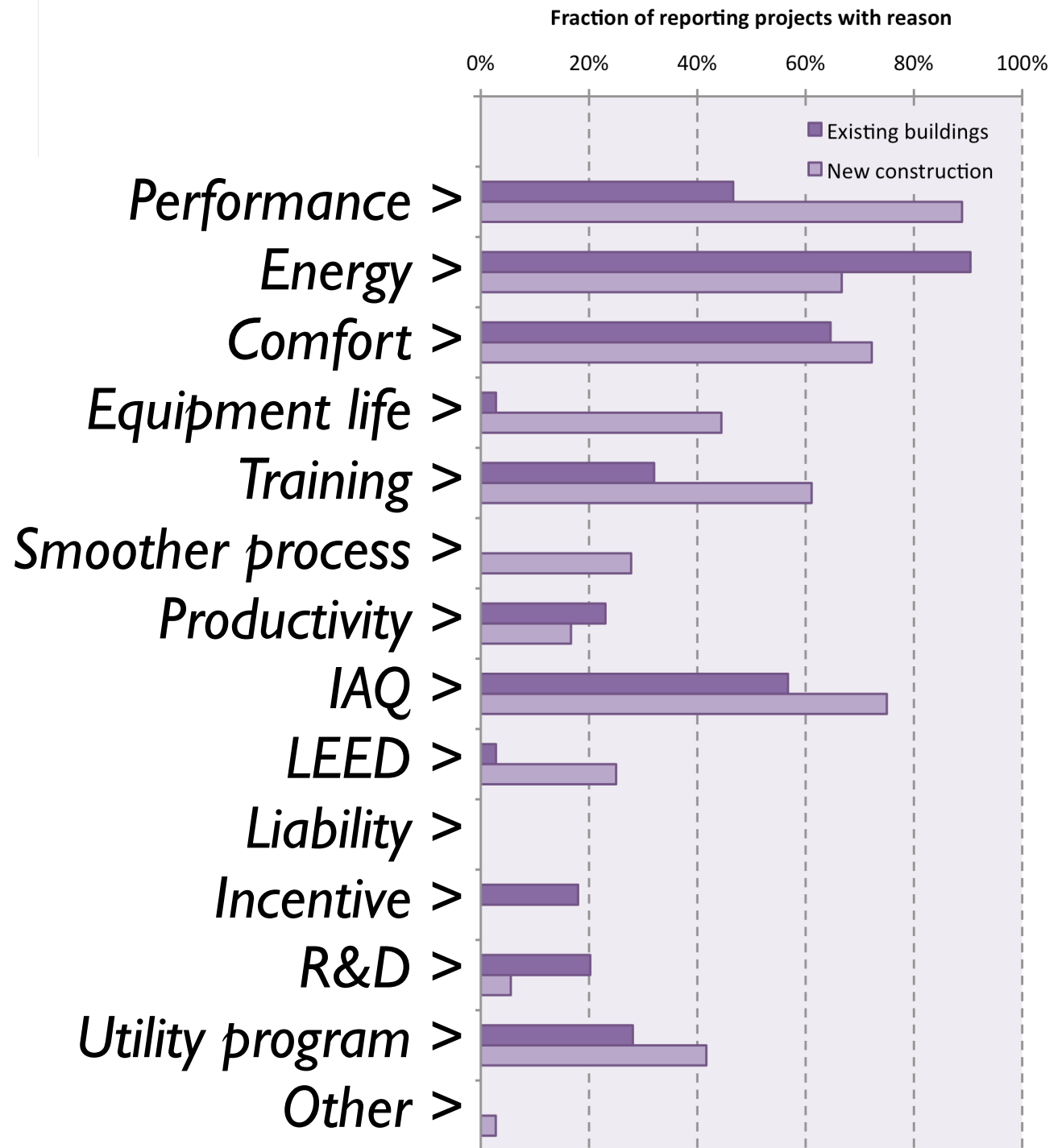
Benefit-Cost Ratio



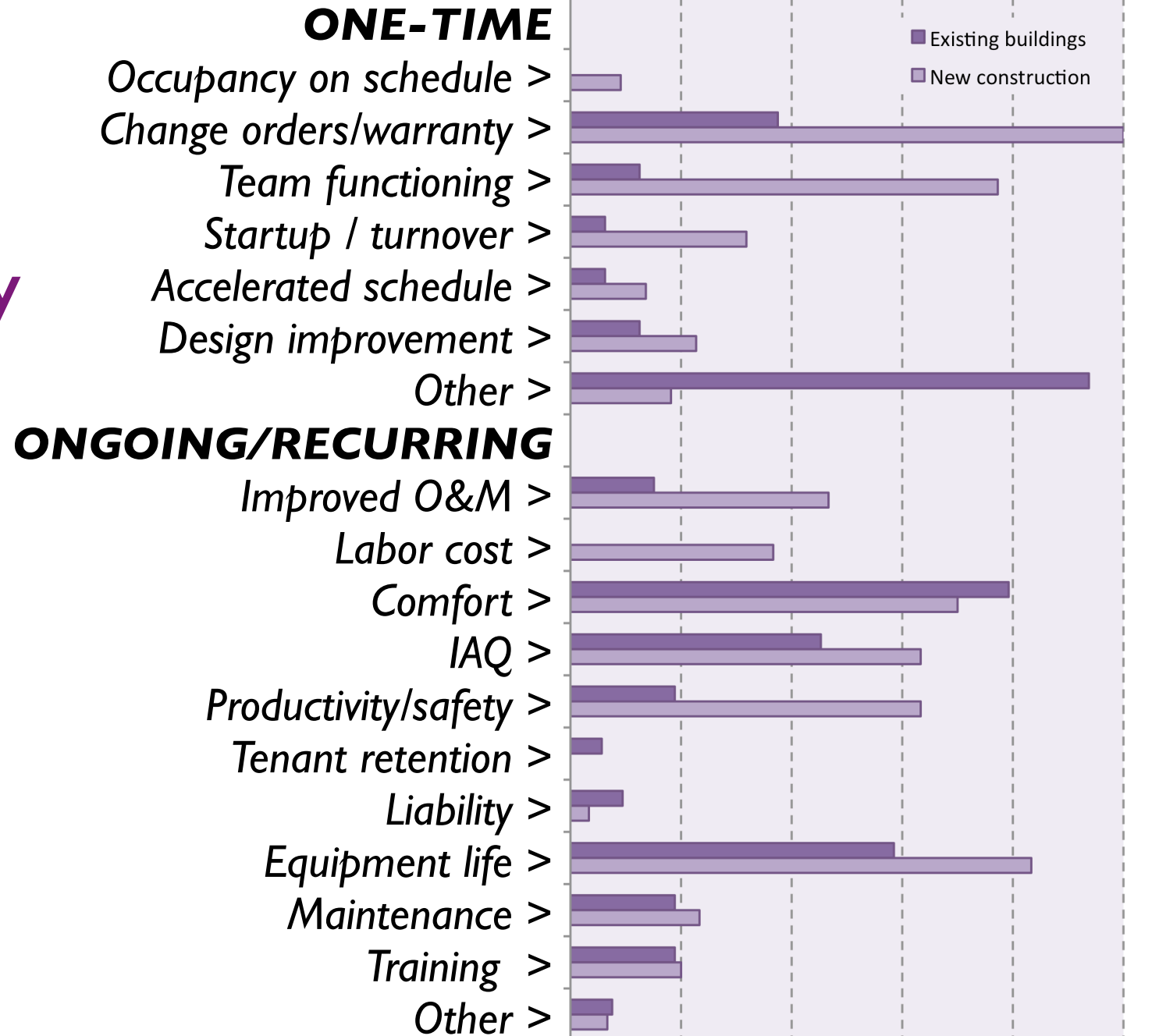
Projects are highly cost-effective



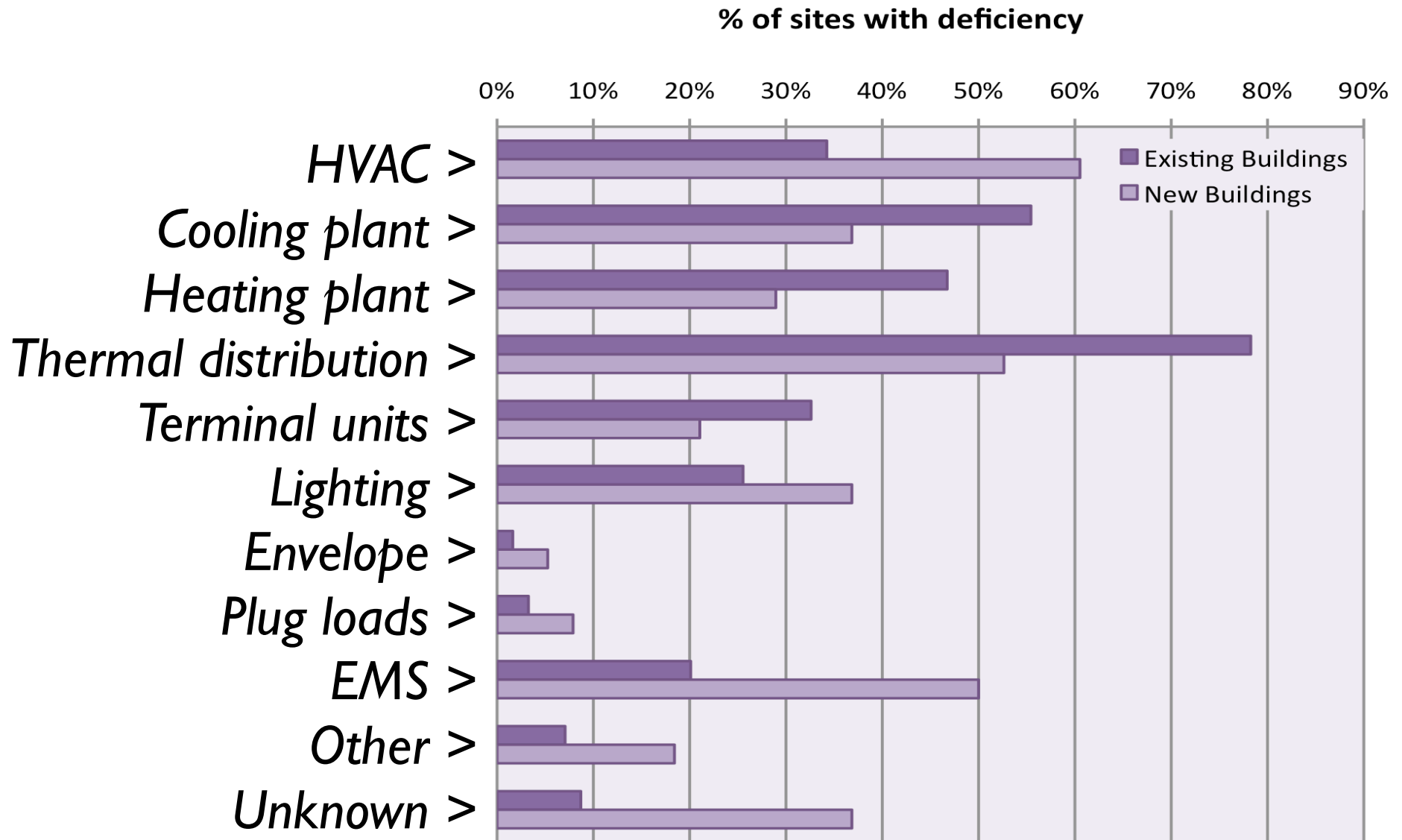
Wide diversity
of reported
reasons to
embark on
commissioning
projects



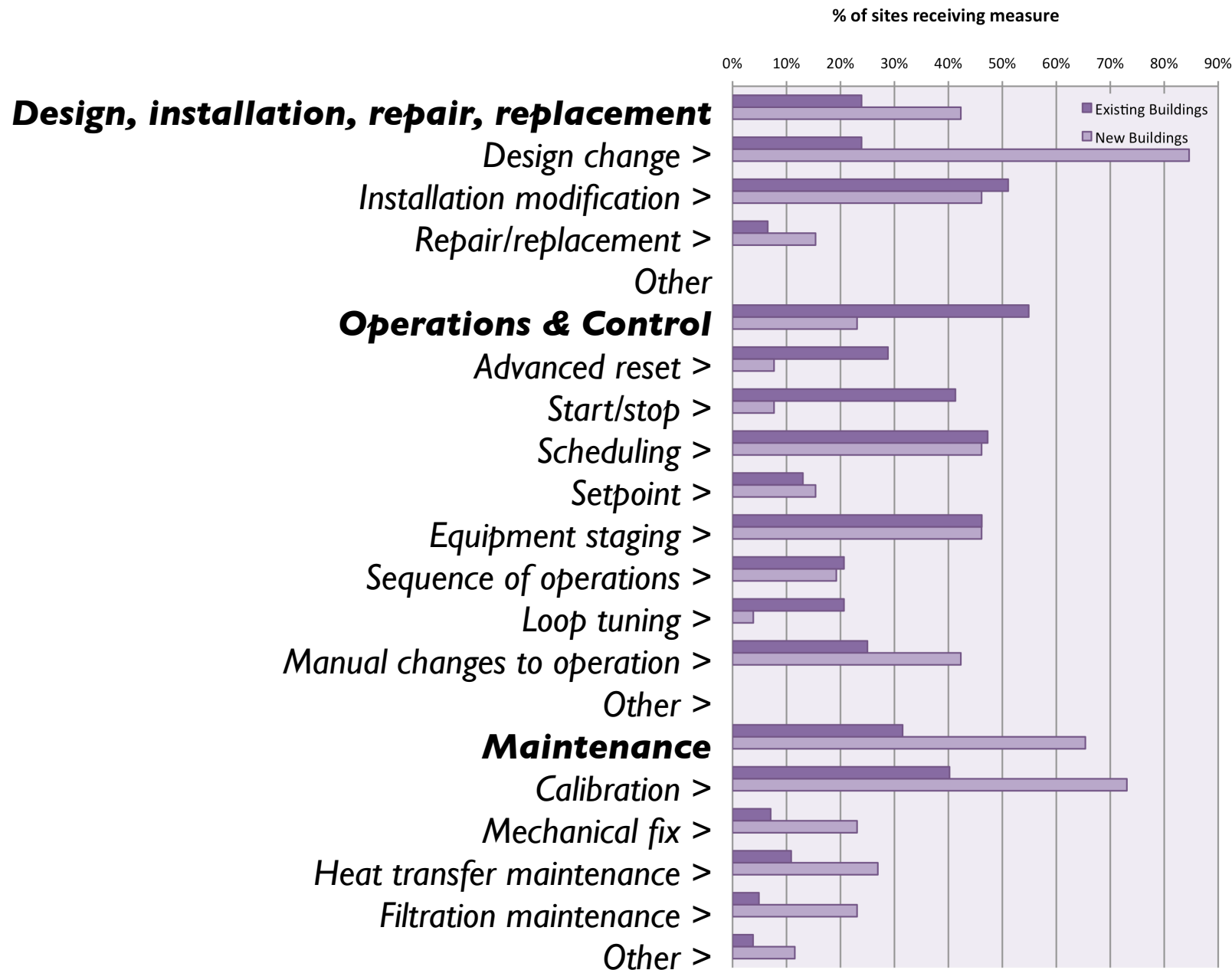
Significant observed non-energy benefits



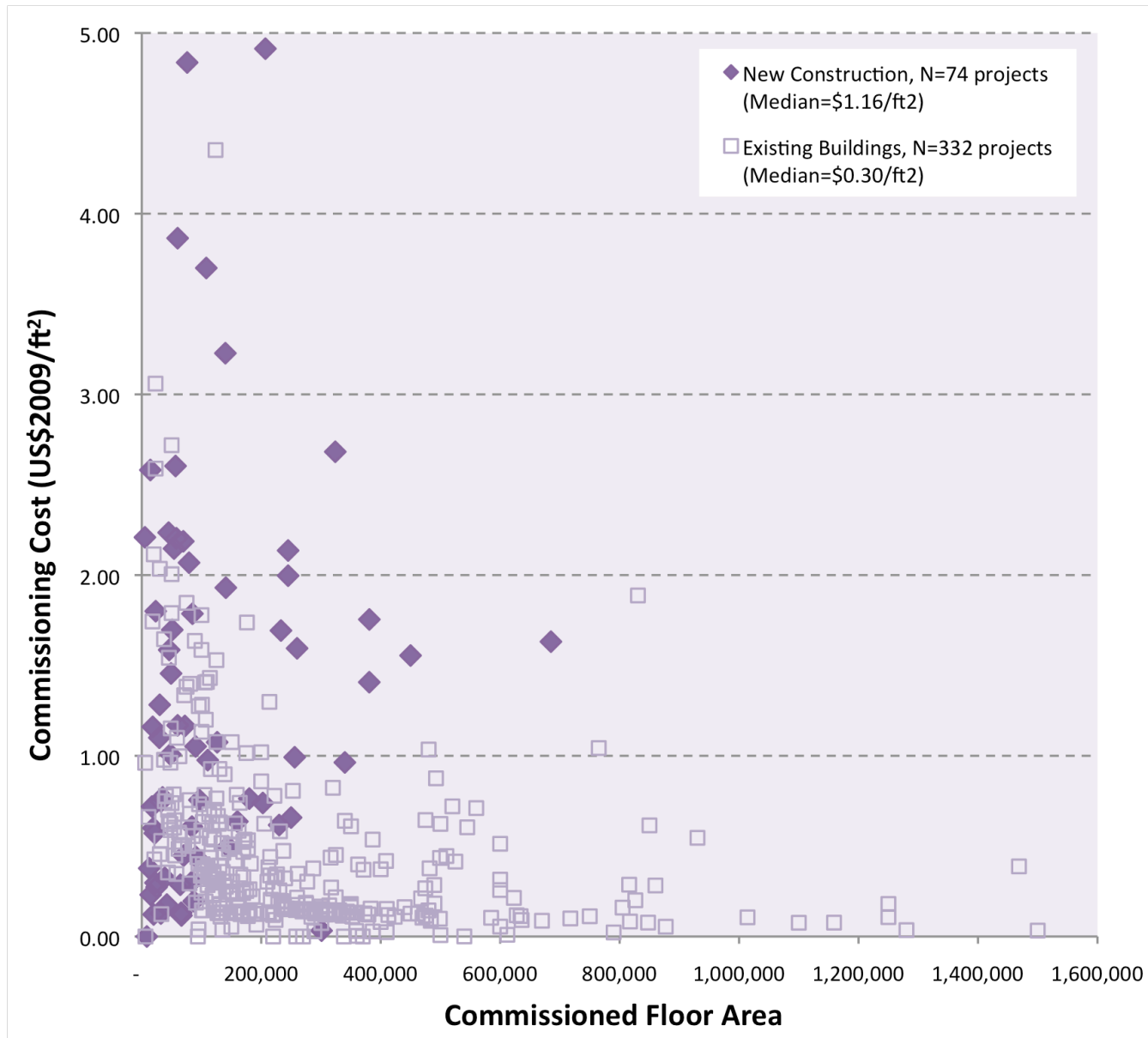
Deficiencies discovered ...



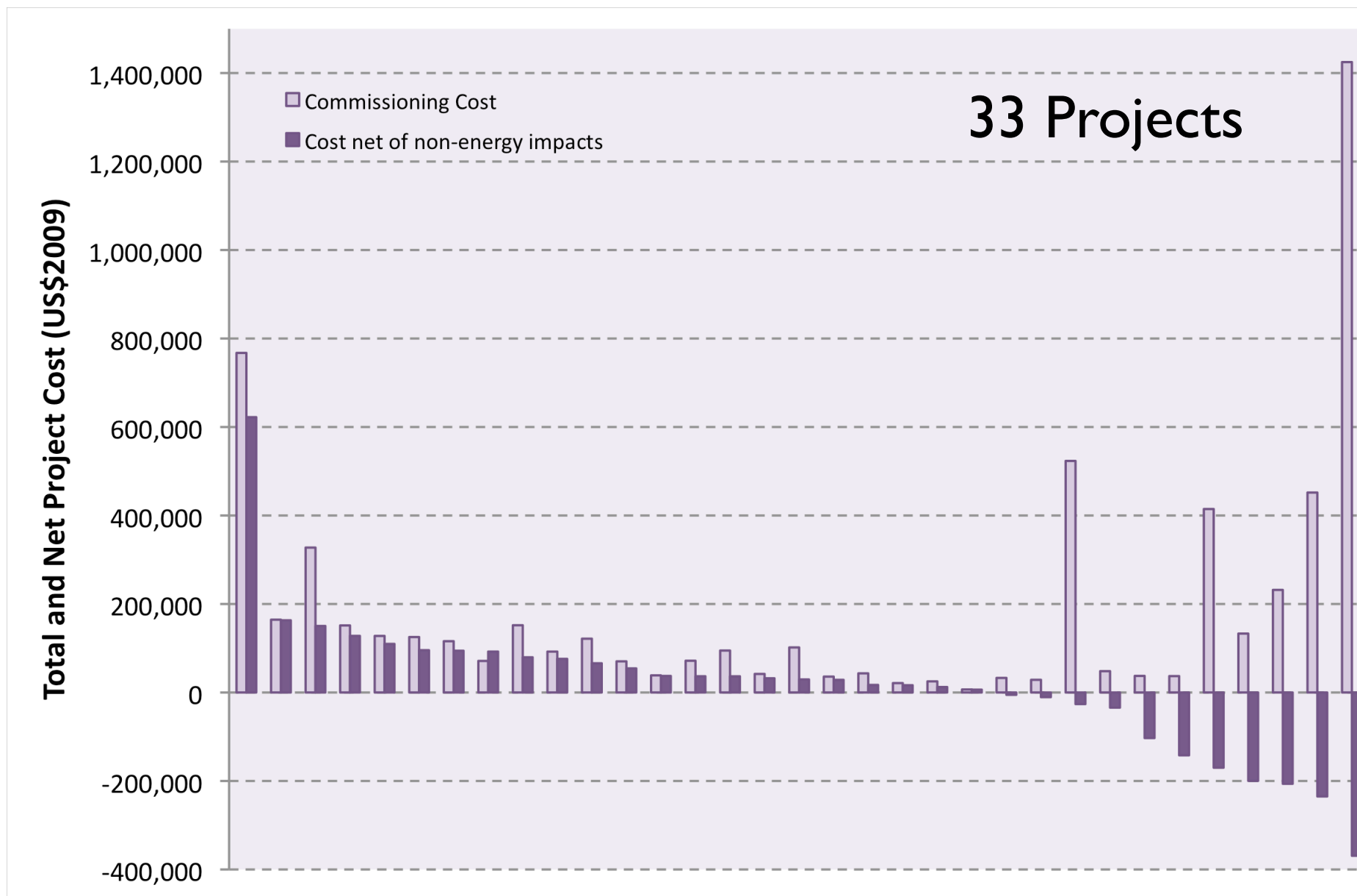
...and the measures to correct them



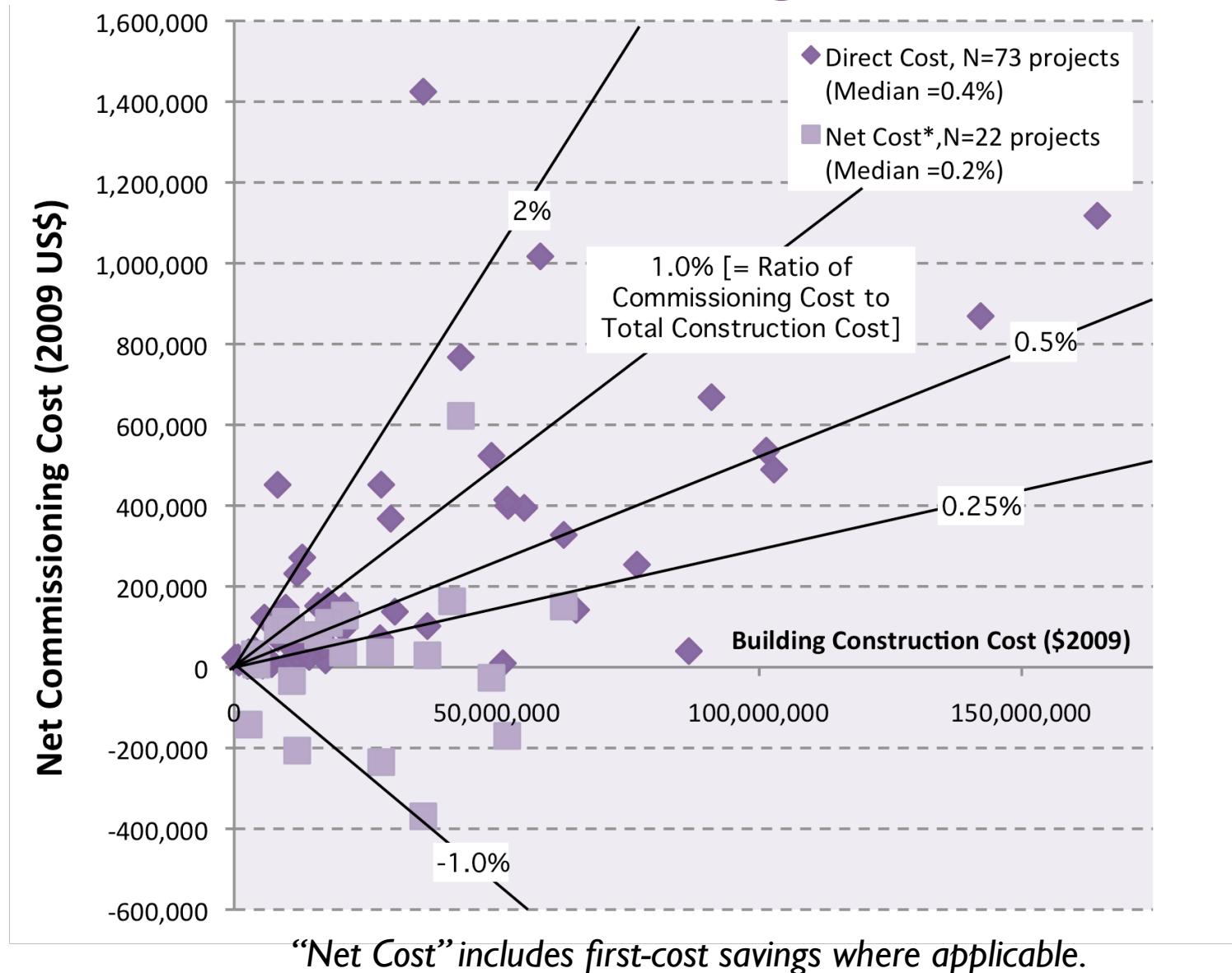
Commissioning costs: new & existing buildings



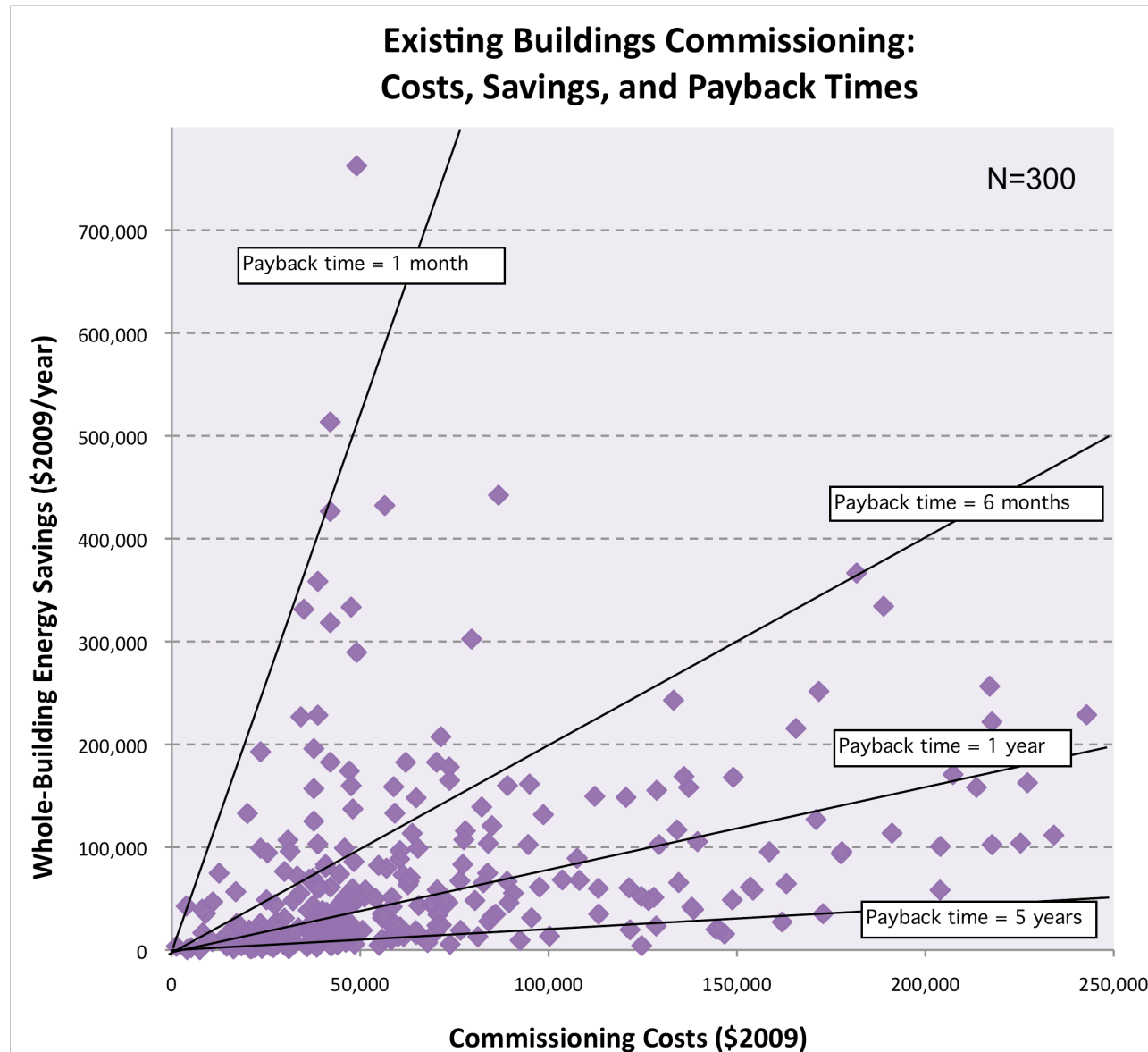
First-cost savings offset project costs



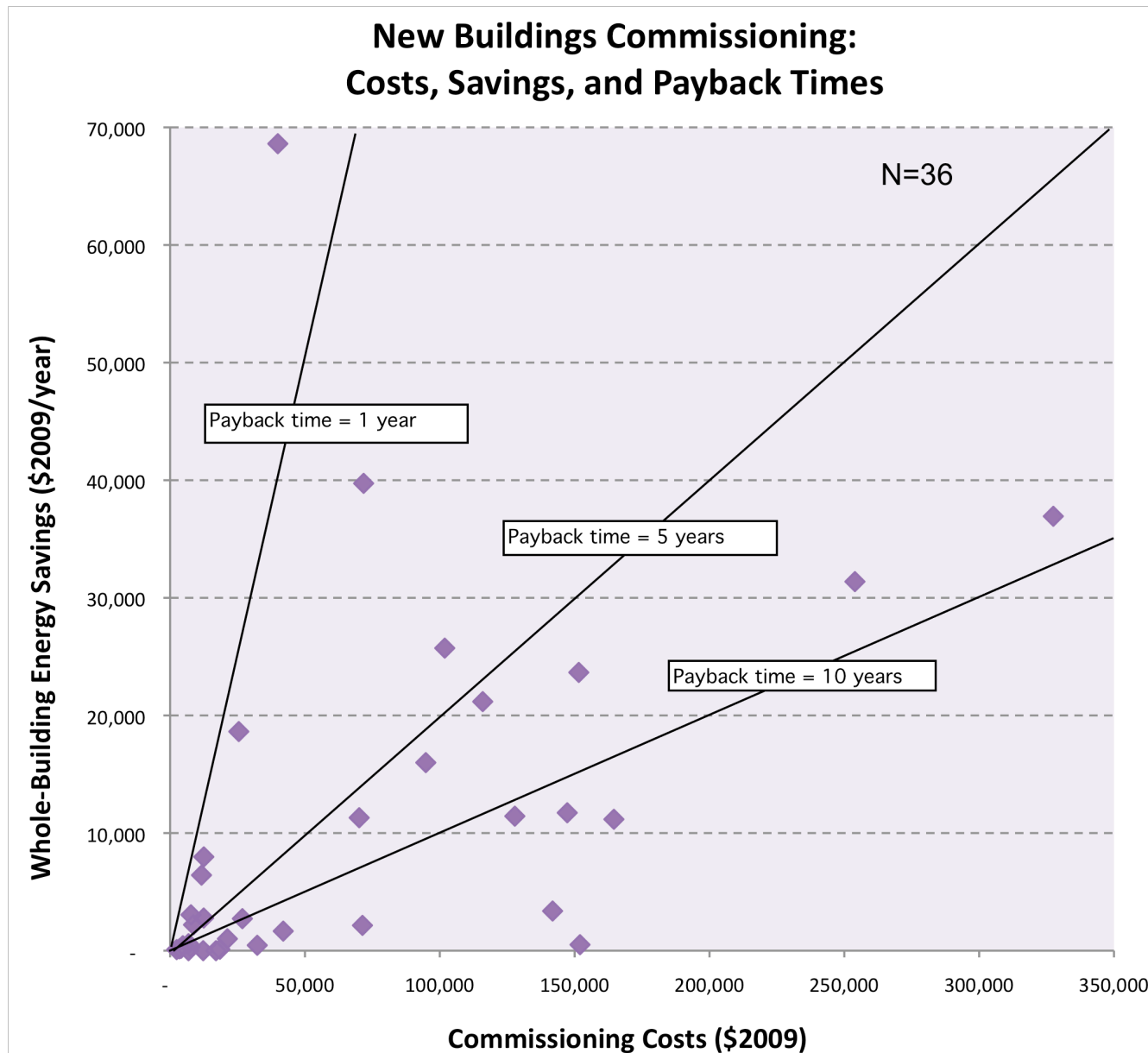
First-cost savings offset half of the commissioning cost



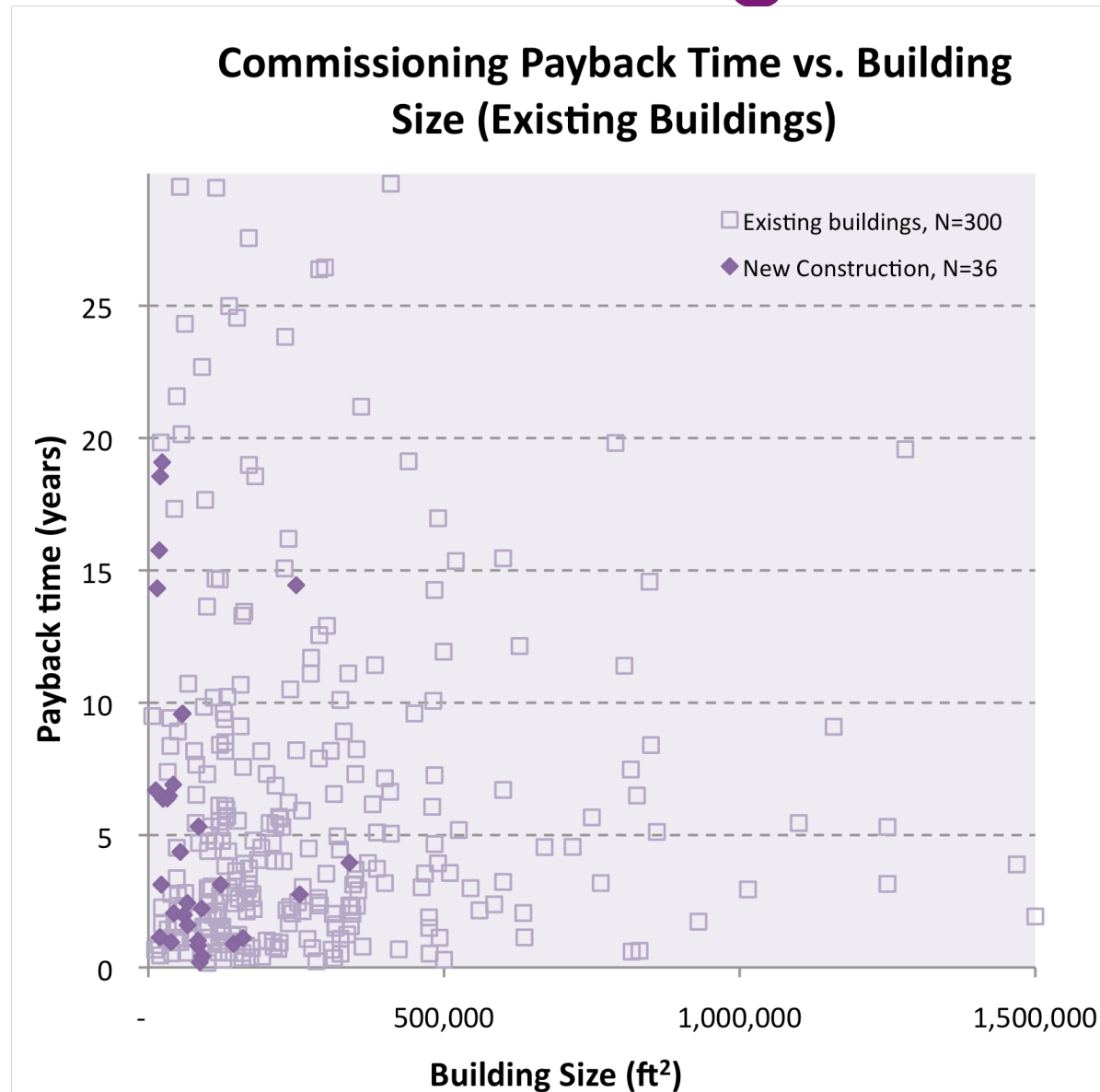
Payback times: existing buildings



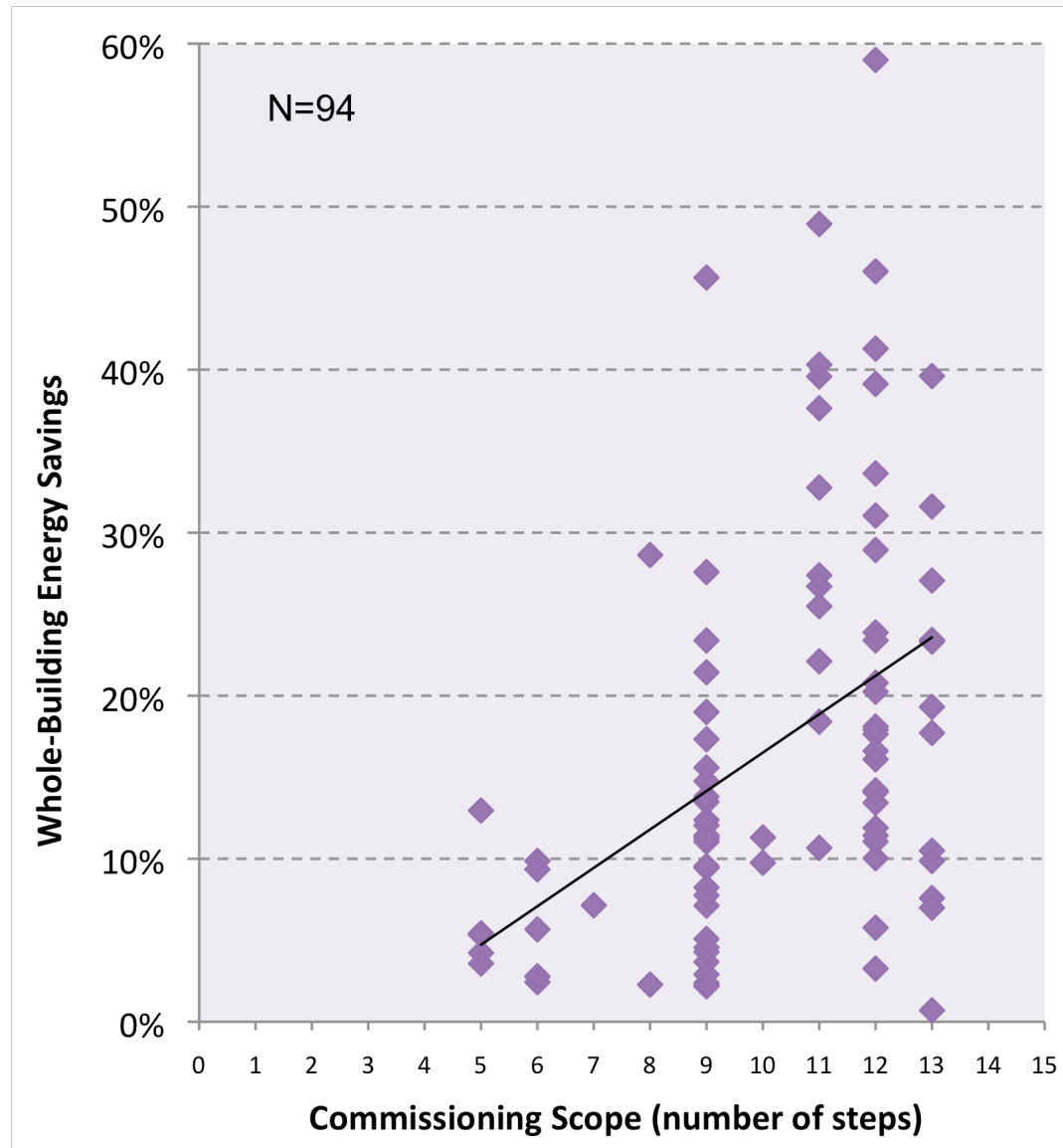
Payback times: new construction



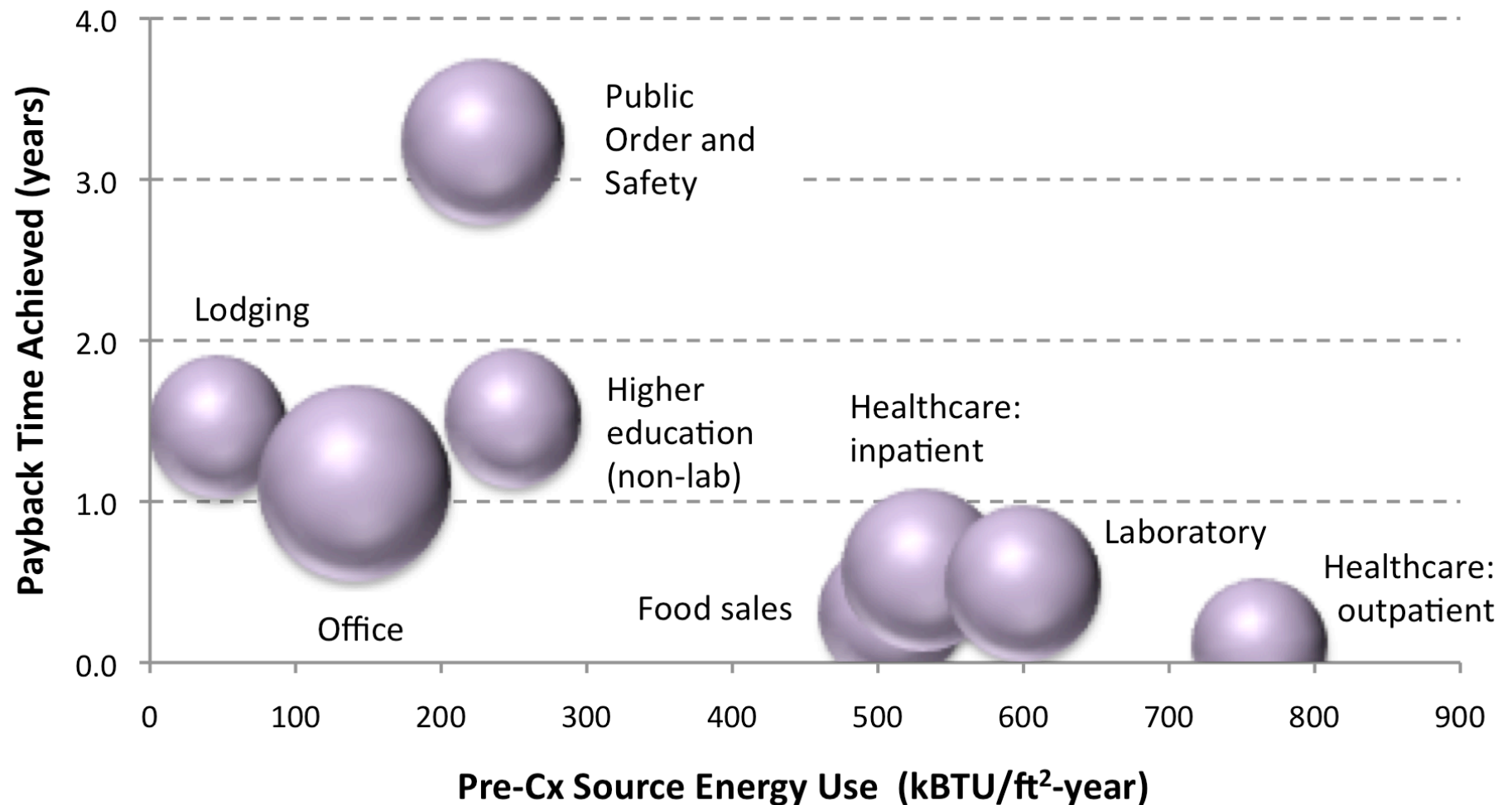
No correlation between payback time and building size



Depth of commissioning versus savings achieved (existing buildings)

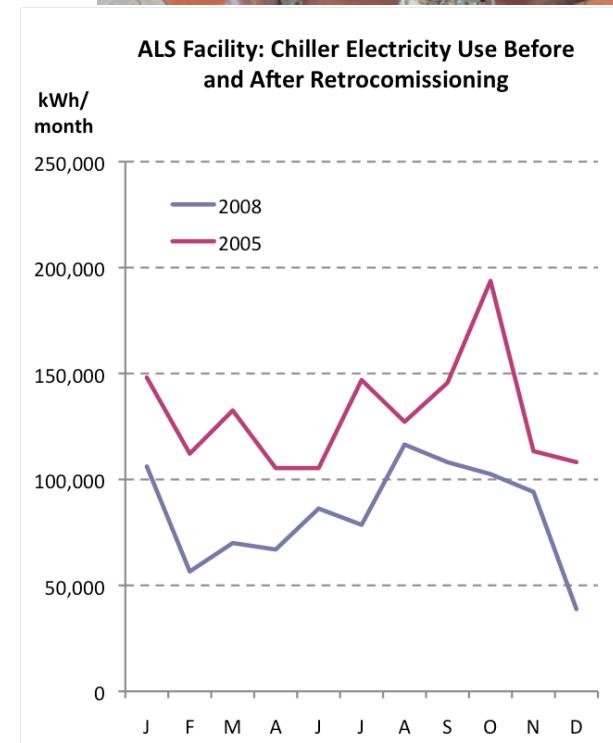


High-Tech buildings attain greatest savings and lowest payback times

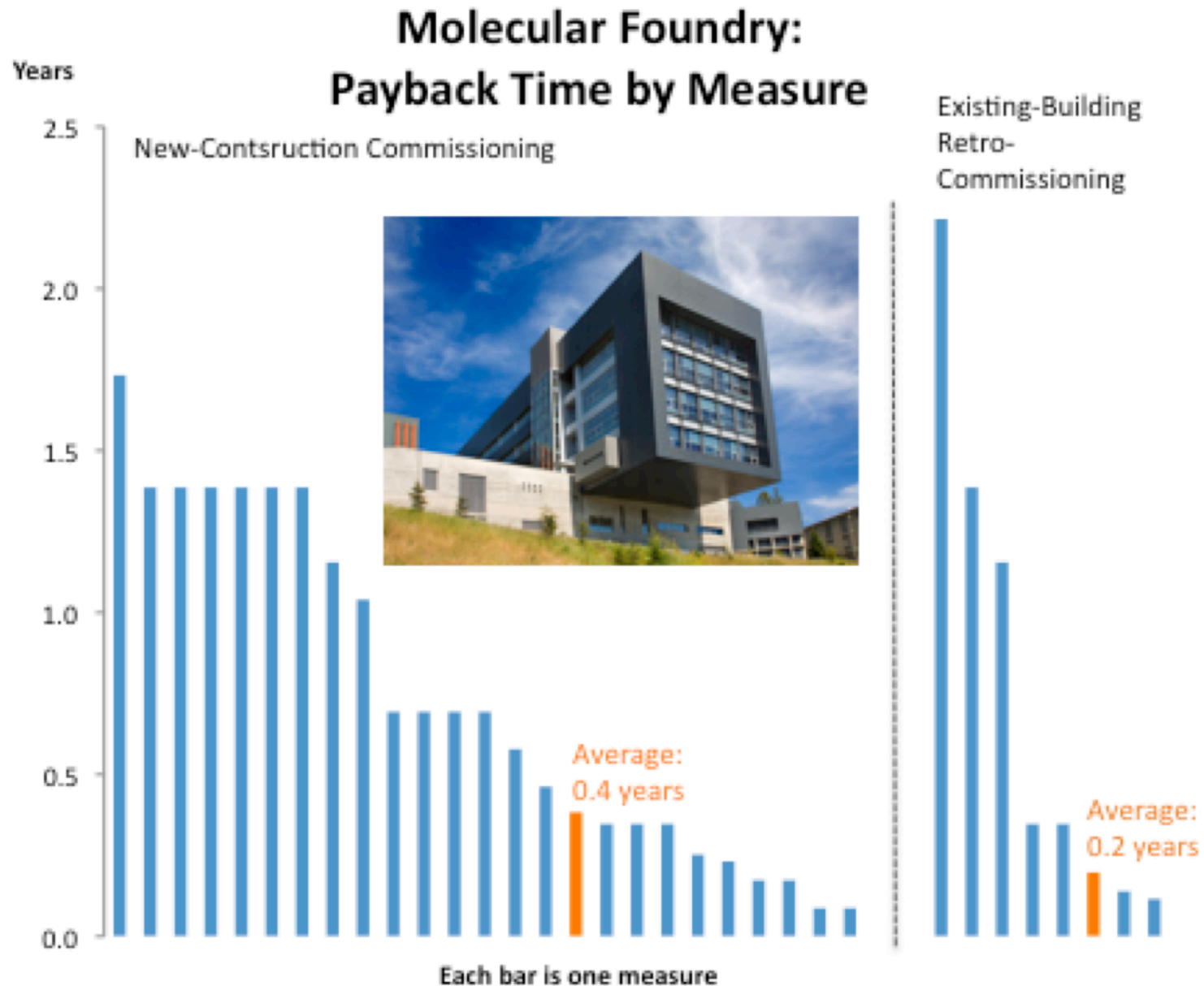


High-Tech Case Study: LBNL Advanced Light Source

- Floor area: 118,573 square feet
- Project cost: \$32,000
- System commissioned: Chillers
- Energy savings: 46%
- Payback time (commissioning cost/annual energy savings) less than one year
- Avoided capital cost thanks to chiller replacement downsizing from 450 to 350 Tons: \$120,000 (based on \$1,200/tonne), i.e., four-times the cost of the commissioning project



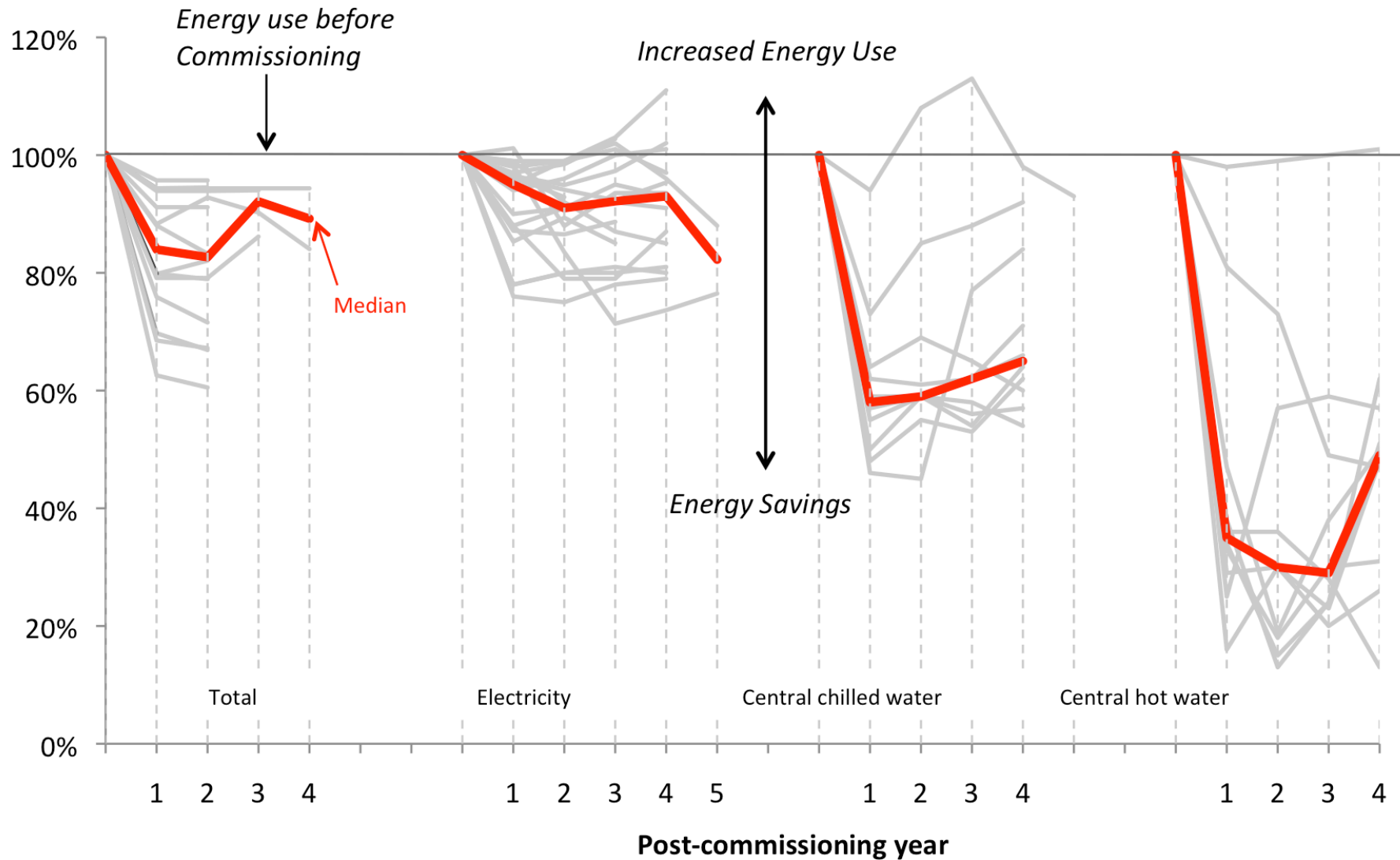
Two Tales of One Building



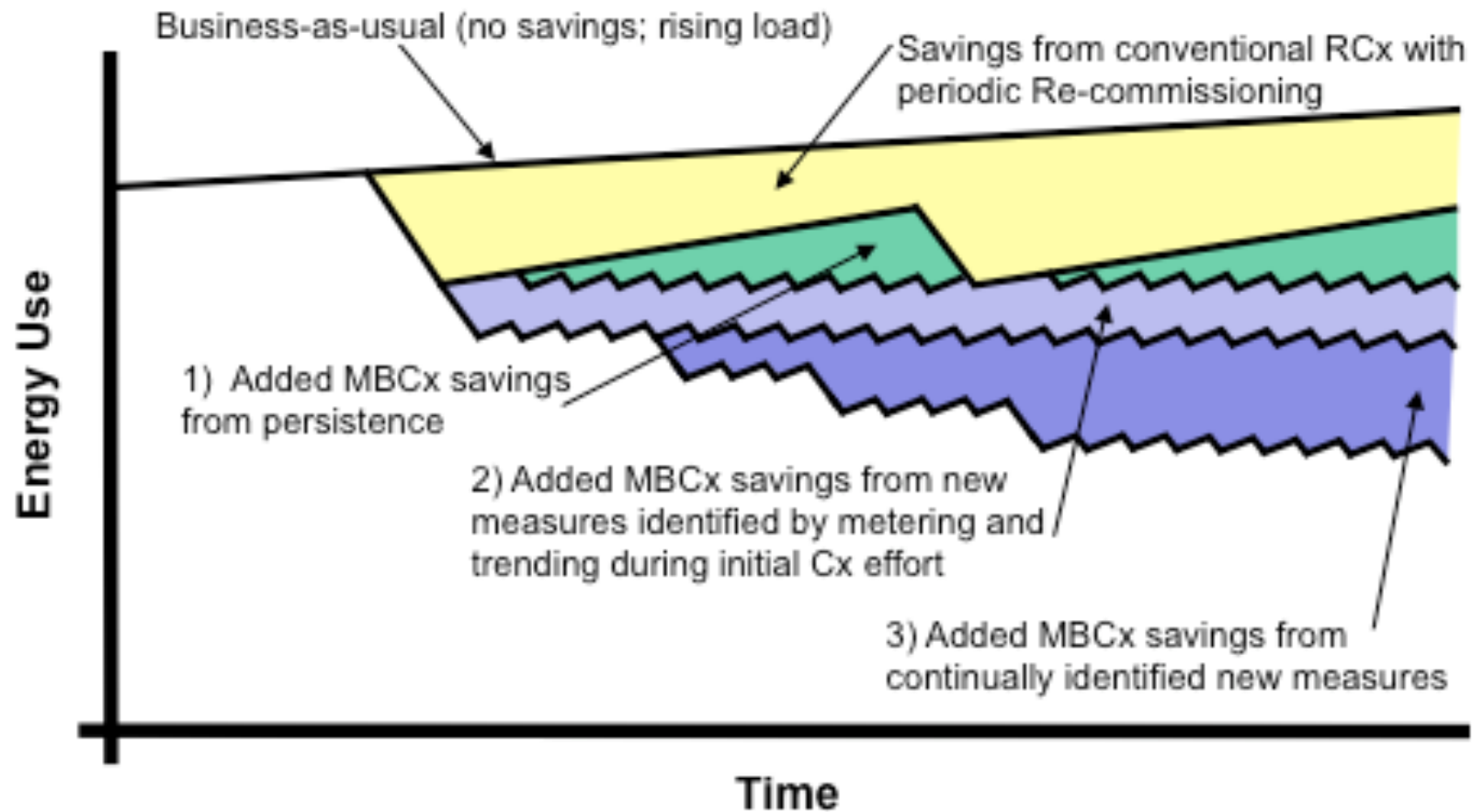
Savings Persistence

N = 36 projects

(Consumption as % of base year)

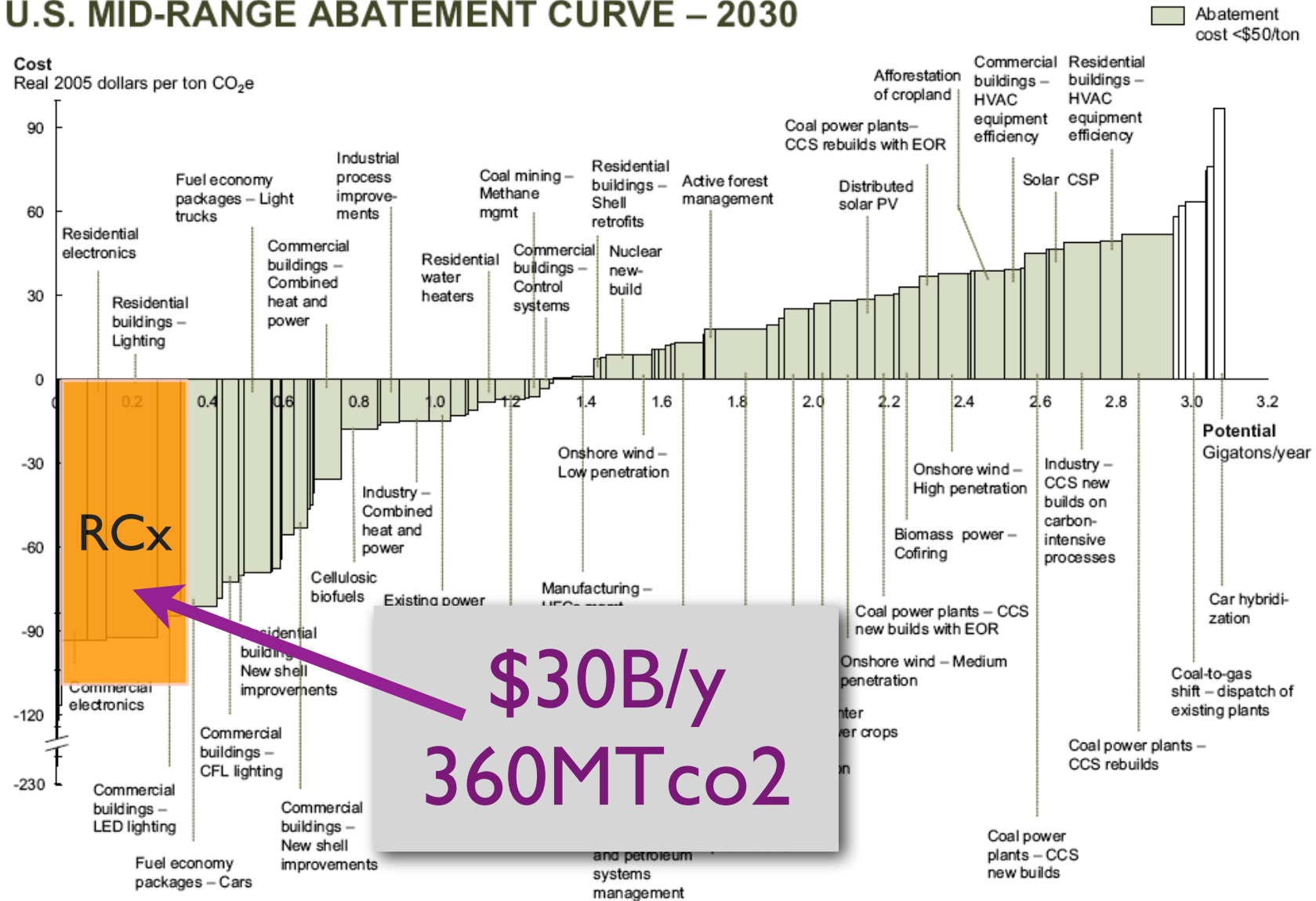


Trust but Verify



The US potential is huge: \$30 billion/yr. by 2030
... but Cx rarely treated well in savings potential studies

U.S. MID-RANGE ABATEMENT CURVE – 2030



Source: McKinsey analysis

Market Potential

- The fledgling existing-buildings commissioning industry has reached a size of about \$200 million per year in the United States.
- Based on a goal of commissioning each building every five years, the potential size is about \$4 billion per year, or 20-times the current number.
- To achieve the goal of keeping the U.S. building stock commissioned would require an increase in the workforce from about 1,500 to 25,000 full-time-equivalent workers, a realistic number when viewed in the context of the existing workforce of related trades.
- But “potentials studies” do a lousy job of considering commissioning

Key Findings (1 of 3)

- Commissioning is arguably the most cost-effective strategy for reducing energy, costs, and greenhouse-gas emissions in buildings today.
 - ★ Median commissioning costs: \$0.30/ft² and \$1.16/ft² for existing buildings and new construction, respectively (and 0.4% of total construction costs for new buildings).
 - ★ Median whole-building energy savings: 16% and 13%.
 - ★ Median payback times: 1.1 and 4.2 years.
 - ★ Median benefit-cost ratios: 4.5 and 1.1, cash-on-cash returns of 91% and 23%.
- Energy savings tend to persist well over at least a 3- to 5-year timeframe. Data over longer time horizons are not available.

Key Findings (2 of 3)

- High-tech buildings are particularly cost-effective, and saved large amounts of energy due to their energy-intensiveness.
- Projects with a comprehensive approach to commissioning attained nearly twice the overall median level of savings, and five-times the savings of projects with a constrained approach.
- Non-energy benefits are extensive and often offset part or all of the commissioning cost.
- Large reductions in greenhouse-gas emissions are achieved, at a negative cost of -\$110 and -\$25/tonne CO₂-equivalent.


Key Findings (3 of 3)

- There is an annual energy-savings potential of \$30 billion by the year 2030, and 360 MT CO₂-eq emissions reductions.
- The corresponding future industry would have a sales volume of \$4 billion per year
- Approximately 24,000 jobs need to be created in order to deliver the potential. This is “small” in the context of the number of people currently employed in related trades.

“Commissioning America” in a decade is an ambitious goal, but do-able and completely consistent with this country’s aspirations to simultaneously address energy and environmental issues while creating jobs and stimulating economic activity.

Thank You

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 HOME >

BUILDING COMMISSIONING

A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions

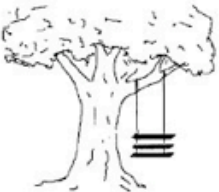
HOME

COST-BENEFIT ASSESSMENTS

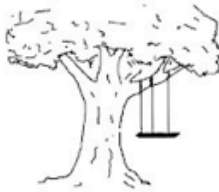
PRESS

RESOURCES


HALL OF SHAME




what the user asked for




what the feasibility study said ...




what the system analyst designed



what the programmer did



what was installed at the user's site.....



what the user really wanted !

The map is not the territory. Building performance routinely strays from the intent at the time of design, resulting in pervasive problems. **Deficiencies** such as design flaws, construction defects, and malfunctioning equipment have a host of ramifications, ranging from equipment failure, to compromised indoor air quality and comfort, to unnecessarily elevated energy use or under-performance of energy-efficiency strategies. Fortunately, an emerging form of quality assurance—known as **building commissioning**—can detect and remedy most deficiencies.

LBNL maintains the world's largest database of actual commissioning project costs and energy savings. The **assessments** begin with compilation of case-study data on costs, energy savings, the patterns of deficiencies and corrective measures, and non-energy benefits. The resulting analyses include cost-effectiveness, savings persistence, and greenhouse-gas abatement.